

42 Muscle Function

Learning Objectives

- To describe how skeletal muscles work during physical activity.
- To learn how the cardiovascular system and muscle function are related.

Process Objectives

- To hypothesize how various stimuli will affect skeletal muscle functions.
- To analyze and graph personal and class data on muscle fatigue.

Materials

For Group of 2

- Clock or watch with second hand
- Laboratory tubing
- Weights (2 books)
- Ice cubes
- 250-mL beaker
- Graph paper

Strategy for Hypothesizing

Think about a physical activity that you have done that caused muscle fatigue. Base your hypotheses on your memory of fatigue from that activity.



What is the relationship between stimuli and fatigue in skeletal muscles?

Introduction

Do you ever exercise to a point where you experience fatigue? Within muscle cells, fatigue is a temporary loss of ability to respond to stimuli. Fatigue occurs when the energy supply to the muscle cells has been depleted and waste products have accumulated.

During moderate exercise, the blood supplies enough oxygen from inhaled air to provide the muscles with energy. This is known as **aerobic** exercise. Well-conditioned marathon runners pace themselves so that their bodies' need for oxygen is about equivalent to the amount of air they inhale. Athletes whose sports require intense, **anaerobic** exertion, such as weight lifters, draw on sources of energy that do not depend on inhaled oxygen.

Proper exercise improves the aerobic capacity of the cardiovascular system and decreases the chance of developing cardiovascular disease.

Prelab Preparation

Read the procedure that follows and make a hypothesis about what will happen to the major muscles in your upper arm — the **biceps** and the **triceps**. The biceps is the muscle on the front of your arm; the triceps is the muscle on the back side of your arm.

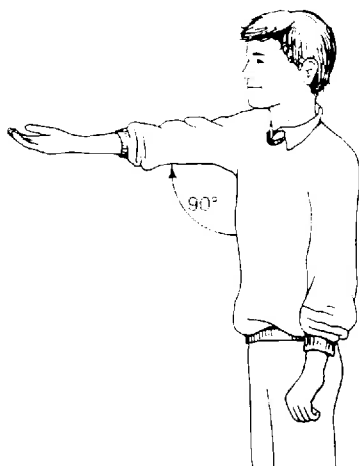
Stretch one arm in front of you and open your hand. Now place your other hand around the upper half of your extended arm. Make a fist and tightly bend (flex) your extended arm.

1. Describe the changes you feel as you bend your arm.
2. Generate several hypotheses about what conditions would make your arm muscles tire quickly.

Procedure

As you do each part of the investigation, your partner will be the timekeeper and recorder. Then you will reverse roles and become the timekeeper and recorder for your partner.

- A. **Continual Muscle Stimulation:** To gather data about muscle fatigue, hold your arm straight in front of you at a 90° angle. With palm turned up, open and close your hand into a fist (flexing) as many times as possible in 20 seconds. Keep your arm out. Without resting between trials, repeat this procedure 9 times. (See drawing on next page.)
3. Your partner will record your counts on your data chart. Average the counts from your 10 trials and enter your average on your data chart.
4. How does the feeling in your arm and hand change as you progress through your trials?



Strategy for Analyzing

Compare the signature from your first trial with your last trial. Does the legibility increase or decrease?

- Record data while your partner performs Step A.
- B. Restricted Blood Flow:** To investigate how blood supply affects muscle function, have your partner tie a piece of laboratory tubing snugly around your upper arm. **NOTE:** Be sure not to tie it too tightly; you should be able to fit one finger under the rubber hose. You will perform 10 trials of the hand-flexing exercise for 20 seconds, as in Step A.

5. Record the number of times for each trial on the data chart and then enter your average.

Record data while your partner performs Step B.

- C. Weight Lifting:** To investigate the effect of weight on muscle function, you will test how long you can hold weights before your arm becomes tired.

6. Predict which arm will tire first. Explain your choice.

Hold one weight (book) in each hand. Keep one arm straight by your side and extend the other arm as in Step A. Hold this position as long as you can. Repeat this action extending your other arm.

7. How long does it take for each arm to become tired? Explain your results.

- D. Varying Temperature:** You will examine how temperature influences muscle activity. Write your full name 3 times on a piece of paper.

8. Do you think your ability to write your name will be affected by how warm or cold your hand is? Give reasons for your answer.

Now tightly hold several ice cubes in your hand for one minute. Quickly drop the ice cubes into the beaker. Immediately write your full name 3 times. Do not dry your hand before writing. **NOTE:** Use pencil; the water will make ink run.

Warm your hands by rubbing them together. Write your full name again 3 times.

9. Look at all of your signatures. How did the different temperature treatments affect your ability to write?

- E. Pool the class data from Step A: Continual Muscle Stimulation on the board. Prepare a bar graph using your data.**

Postlab Analysis

10. Did you experience muscle fatigue? Under what conditions?
11. How did the restriction of blood flow affect your counts?
12. What can you infer about the relationship between the cardiovascular system and muscle fatigue?
13. Study the graph you prepared in Step E. How do your results compare with the class data? Suggest variables that might have influenced the class results. Would you consider your own results average, above average, or below average?

Further Investigations

1. Repeat the investigation experiments with subjects of different ages and compare the results with your results.
2. Contact groups that study cardiovascular or muscular function and disease for information about their specific research. Ask how physical activity deters later health problems. Also ask how activities such as musical training can benefit an individual.